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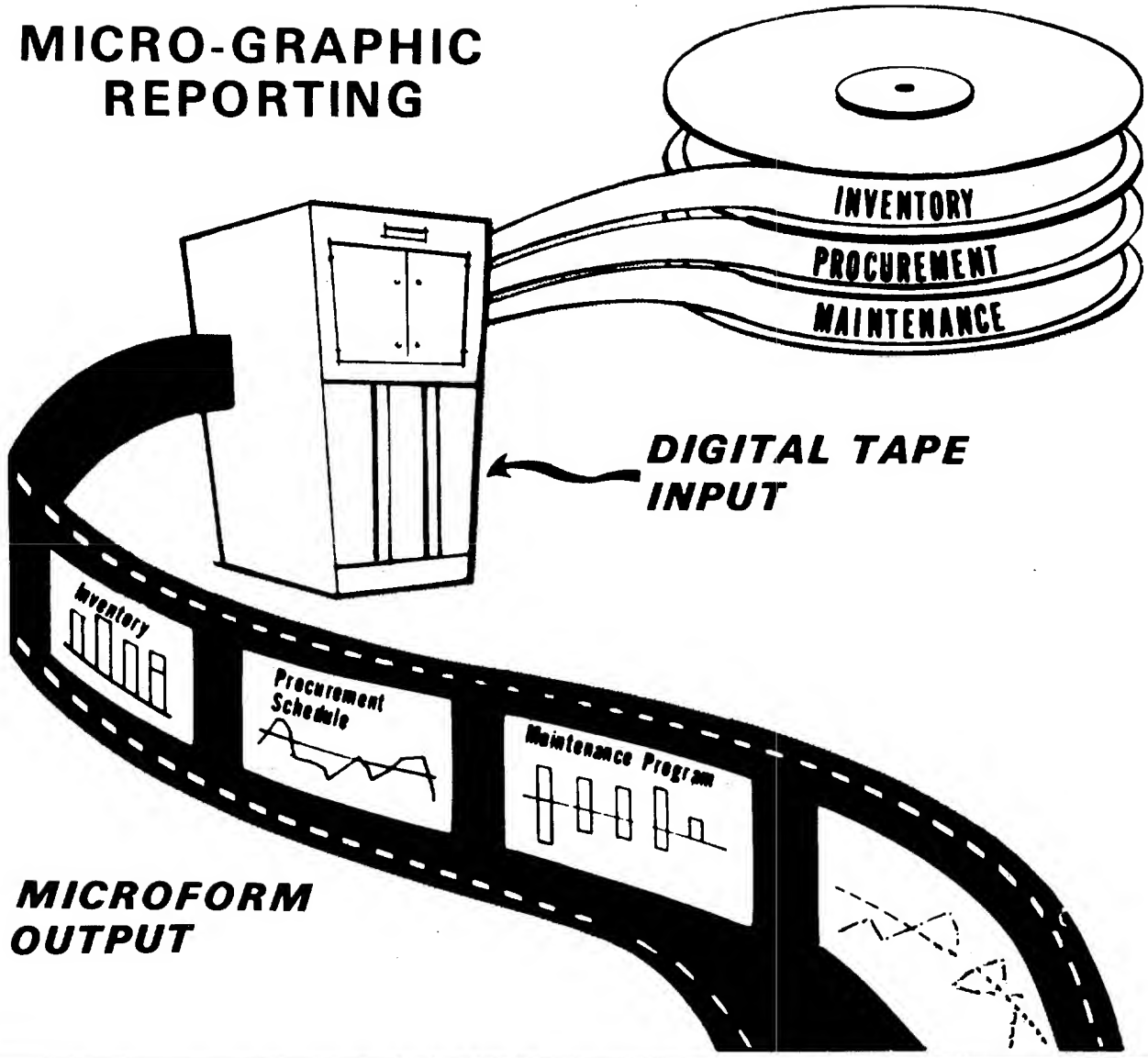
NAVY MANAGEMENT REVIEW



MICROFORM TECHNOLOGY UNDERGOES MANAGEMENT REVIEW

Navy Management Review

NAVSO P-910

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IN THIS ISSUE...

COVER:

Computer-Output Microfilm within an automatic data-processing equipment environment is illustrated on the cover of this month's microform issue of the NAVY MANAGEMENT REVIEW. The Micro-Graphic Report system illustrated produces a graphic display of three sample business-system data segments (inventory, procurement, and maintenance) for easier and more effective high-level management review and decision. Use of this Micro-Graphic Report concept is detailed in an article herein entitled "Computer Micro-Graphics To Speed 'Third-Generation' Management."

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PURPOSE *of the NAVY MANAGEMENT Review is to promote better management in Navy and Marine Corps operations and to be a key channel of communication for management improvement in the Naval Establishment. It is dedicated to informing, stimulating, and describing programs and techniques that readers can apply to their own management problems as well as to publicize actual accomplishments in such a way that they can be considered for use in all or other parts of the Naval Establishment. It is published by the Navy Management Review Staff Office, Office of Information Systems Planning and Development in the Office of The Special Assistant to The Secretary of the Navy, Main Navy Building, Room 0122, Washington, D.C., 20360.*

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MAGAZINE DISCONTINUED: *The NAVY MANAGEMENT REVIEW (NAVSO P-910) will cease with this issue.*

"Now Hear This..."

New Role For Microforms

Microforms of various kinds are moving rapidly into a new and productive role as an integral part of modern management information systems. Microform has come a long way from its first best use in reducing all kinds of records to rolls of film (microfilm). "Microform" is a term used to encompass many kinds and uses of microfilm. When microform is a principal output of an Automatic Data Processing (ADP) system, or is computer-based, it is known as "COM" -- an acronym for Computer-Output Microfilm.

As with any new tool, Navy management and technicians must look carefully at its attributes, costs, and limitations before deciding when and where to use it. It must be compared with alternatives. In some cases, a microform memory will be better than magnetic tape. Microform may be superior as a non-impact printer or as a graphic display. Opportunities abound for cost/effective use of microform in information storage and retrieval systems.

Articles in this issue of the NAVY MANAGEMENT REVIEW provide ideas and experiences from managers currently working with microform systems. They represent present-day continuation of initial microfilm efforts vigorously pioneered by the Navy, first in World War II with records storage and disposal, and later, in the 1950's in one of the first major applications of aperture cards to engineering drawings. The first direct COM use was about 10 years ago at the Naval Ship Research and Development Center at Carderock, Maryland, and at the Naval Weapons Systems Command Laboratory at Dahlgren, Virginia.

I commend microform technology and encourage careful study of its potential values, remembering that a cautious, well-planned system design and conversion is extremely important. The need for thorough systems analysis in this case is especially acute because of the wide variety of microform and means for conversion now on the scene.

JAMES G. WOODRUFF
The Special Assistant to the Secretary of the Navy

An Overview Of Microforms For Navy Management

By Charles DeVore
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A significant example of the recent acceptance of microforms within the Executive Branch of the Federal Government is the production in the past year of 20 million microfiche by five agencies – the Department of Commerce Clearinghouse for Federal Scientific and Technical Information, the Department of Health, Education, and Welfare's Office of Education, the National Aeronautics and Space Administration, the Atomic Energy Commission, and the Department of Defense. Since a 100-page report can be reproduced on two microfiche measuring only four-by-six inches each, these microfiche represent a reduction of about one billion pages of paper with resulting savings in space, storage equipment, transportation, paper, and reprinting costs. (See photos.)

"Microform" is the general name for any film or paper format containing images of larger original documents greatly reduced in size (micro-images). Among the microforms in most common use are microfiche, microfilm, micro-opaques, and aperture cards.

Microfiche

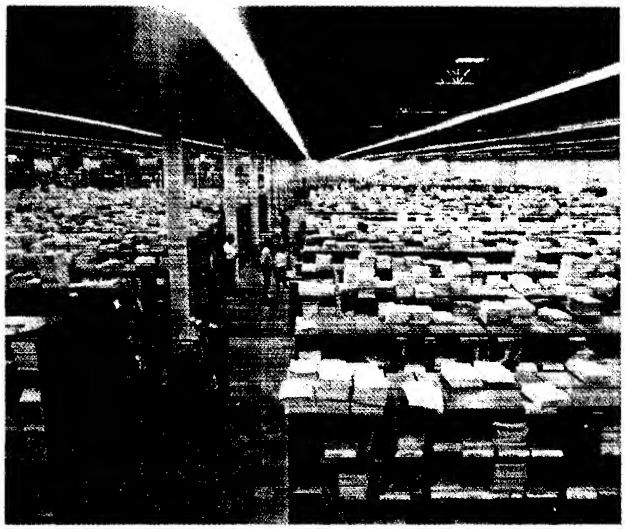
"Microfiche" is a single sheet of small film recording multiple micro-images in a resulting grid pattern. Produced in several sizes and formats, standard specifications for microfiche were developed in 1964 by the Committee on Scientific and Technical Information (COSATI). Located in the Executive Office of the President, COSATI is a standing committee of the Federal Council for Science and Technology. The Council is a confederation of Federal departments and agencies whose chairman is named by the President of the United States. The COSATI specifications have been adopted by many Federal and non-Federal agencies as well as foreign governments. One of the microfiche formats utilizing the COSATI standards provides for a piece of film measuring approximatively four-by-six inches (104-by-148 millimeters) containing 60 images or frames (arranged in five rows of 12 frames each). This requires a 20-time (20X) photographic reduction from the size of the original document. Another COSATI standard microfiche format provides for 98 images and utilizes a 24-time (24X) reduction. The principal application for microfiche is in reproducing multi-page records such as catalogs, reports, and technical publications.

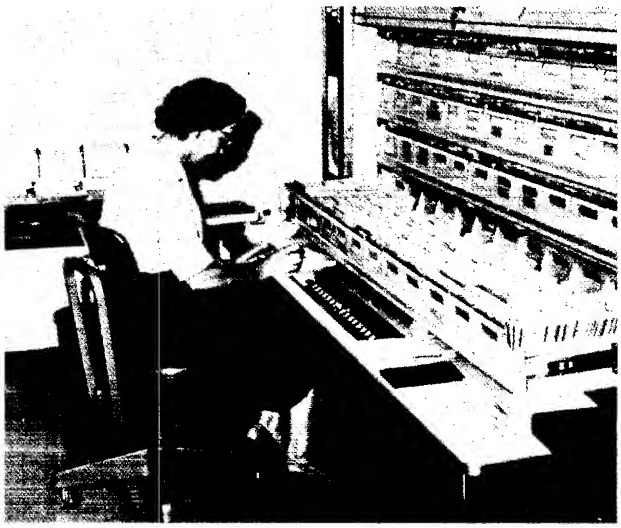
Recent developments in image miniaturization by industry have produced "superfiche" and "ultrafiche". Similar to "microfiche", they provide for more images on a single sheet of film at greater reductions. "Superfiche" involves reductions ranging from 40-to-100 times smaller than the original document, whereas "ultrafiche" makes possible reductions in size of over 100X with more than 2,000 images on a four-by-six inches or six-by-eight inches piece of film. One process of "ultrafiche" (involving a reduction of 220-to-one) would permit all the books on the 270 miles of shelving in the Library of Congress to be stored in six standard filing cabinets. Although this is not scheduled for the library, a "superfiche" or "ultrafiche" microform system is planned for use on Navy catalog data as the result of recent tests of several microform systems undertaken by the Naval Supply Systems Command.

"Microfilm" is the most common microform. Microfilm is a fine-grain, high-resolution reel in roll or cartridge format of photographic film containing micro-images. It may be in the usual 16 or 35 millimeter size or in the larger 70 or 105 mm size film. A 16-mm film cartridge, for example, could record about 1,500 micro-images with a 24X reduction.

Microfilm is not a recent development. It was used extensively in World War II. A familiar application during that period was the "V-mail" microfilm used by the public for overseas correspondence. Wartime use of microfilm also promoted its adoption as a security medium for storing government and industrial records.

One application of microfilm known as Computer-Output Microfilm (COM) was introduced by the U. S. Department of the Navy about 10 years ago. It transfers to microfilm at computer-channel speeds and into English format the digital data from automatic data processing equipment. A reverse of this microfilm technique is used by the U. S. Bureau of the Census. Known as the Film Optical Scanning Device for Input to the Computers (FOSDIC), this unique system converts the data from the microfilm into binary inputs (bits) on magnetic tape that will, in turn, be read and processed by the computer.





MICROFICHE POWER FILE: *The nearly 1.5 million reports shown above (left) stored in some 30,000 square feet at the U. S. Department of Commerce Clearinghouse for Federal Scientific and Technical Information can be contained in six semi-automatic power files such as the one (with operator) shown (right) which contains about 400,000 microfiche records. This power file holds copies of some 250,000 reports available for semi-automatic retrieval. (Photos courtesy of Clearinghouse For Federal Scientific and Technical Information, U. S. Department of Commerce.)*

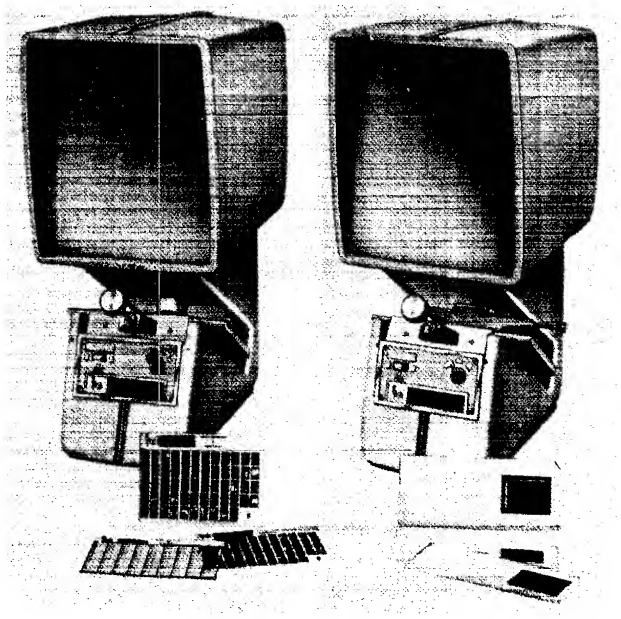
Many libraries use a microform system called "micro-opaques" for card catalogs. A sheet of opaque material, it comes in various sizes ranging from three-by-five to six-by-nine inches and contains about 80-to-100 images. The concept was evolved about thirty years ago.

Navy engineers are most familiar with another microform known as the "aperture card". It consists of a computer tabulation card with a subject area and a rectangular cutout or hole specifically designed to hold a frame (or several frames) of microfilm. One of its main applications is in engineering drawing systems.

The latest application of this microform, however, is by the U. S. Patent Office. It uses a new process of the "aperture card" for issued U. S. patents. A single "aperture card" is used to record each eight pages of a patent. Already adopted by several other countries, the new process is being considered for acceptance on an international basis.

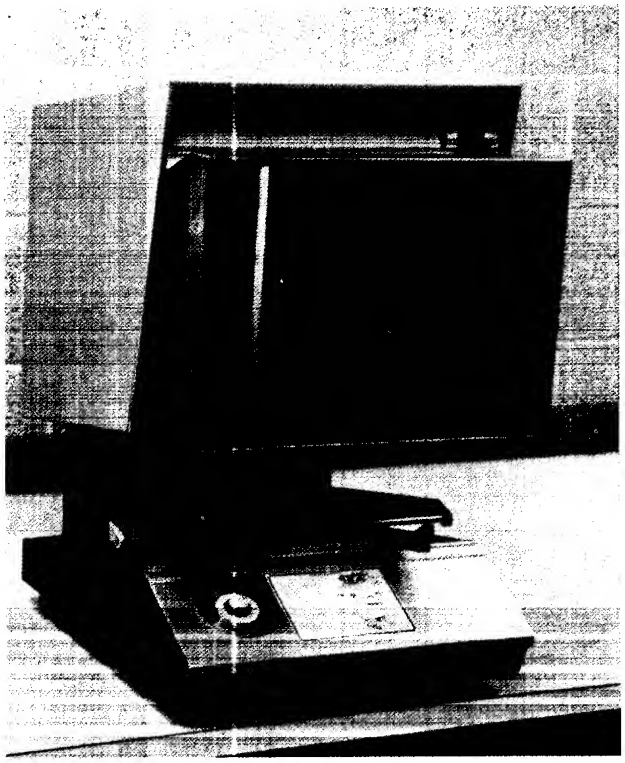
Since microforms reduce original documents to miniature size, it is essential for users to be able to "blow back" the reduced images to a readable size. A complete microform system, therefore, includes a photographic recorder or duplicator; a subsystem to retrieve required microforms with speed; and a viewer (reader) and viewer/printer. (See photo).

Good photographic recorders or duplicators are available but the poor quality of some microfiche reproduction has been responsible for failure by many to accept microfiche. No reproduction, however, can be better than the original document and poor quality of microfiche is often due to the poor quality of the orig-



MICROFORM VIEWERS: *A microfiche reader (left) and an aperture card reader (right) to "blow back" images for users of the information recorded on the reduced-size film. Sample microfiche records are shown before the microfiche reader and sample aperture cards in front of the aperture card reader. (Photo Courtesy of Defense Documentation Center.)*

VIEWER/PRINTER: *The reader/printer shown above has a wide-screen attachment. Users may view selected information from the microform and then print permanent record copies for their files.*



inal material. Improvements in microfiche quality, however, are being made. New "positive" microfiche, for example, results in a black-on-white image rather than the more common "negative" microfiche of white-on-black. There is technological capability also for color microfiche.

Documents on microform must be readily accessible to users. A reliable retrieval subsystem to locate microform material is essential. (See photo.)

Low-cost viewers under $100 and viewer/printers under $300 are available. Several light-weight portable viewers are being offered commercially. Low-cost equipment is achieved sometimes, however, at the expense of desirable features in the larger and more expensive equipments.

A recent listing of viewer (reader) and viewer/printer (reader/printer) equipment for microforms was published in March 1970 by the Defense Documentation Center (Report DDC-TR-70-1 entitled "Microfiche Viewing Equipment").

Among the advantages of all microforms are reduced costs for initial printing, processing, and transporting of documents and savings in space and storage equipment. With these cost benefits established, one may well ask, "Why aren't microforms more widely used?" A first answer, of course, is a normal resistance to change. When one is accustomed to having a paper copy of a report on which one can make marginal notes, one is reluctant to change to a different format which no longer provides that convenience. Then, too, there is what has been referred to as the "pack-rat" or "squirrel" syndrome for accumulating stacks of paper.

One solution to "paper pollution", of course, would be to charge for paper copies of reports, since it has been estimated that a reader is seldom, if ever, interested in more than 10 percent of a particular report – and even that estimate may be high. Thus the Defense Documentation Center initiated a service charge in July 1968 of three dollars a copy for paper (hard) copies of reports while making microfiche available without charge. Within less than a year, the Center reported reversal in the trend of requests for reports in hard-copy format. Requests for reports in microfiche now account for 80 percent of the total. The user makes a photo copy of the microfiche report if he wants a permanent copy and has access to a microform viewer/printer.

Future Acceptance

An important factor which will contribute to the acceptance of microform in the future is its increased

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How Microforms Help Solve Typical Information Problems

By Robert H. Cain
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General Services Administration

With the advent of the computer, management turned its attention from microform and looked to the computer as the new medium for solving its information processing-and-storage problems. During the years that followed, however, there have been many advocates who never wavered in their conviction that the unique qualities of microform will cause it to become increasingly important to national, state, and local government and to industry. These supporters have been improving the quality and versatility of the microform and its related equipment so that it is a far different tool now than it was a few years ago.

Future computerized data banks; the extension of the computer as a daily working tool of an office; and the widespread use of remote terminals will dictate a need for maintaining selected, essential, high-use data in machine-language code. And, on the other hand, future needs for greater compactness, speed, convenience, and economy in the storage, retrieval, and dissemination of large volumes of static or semi-static data, as well as documentary and reference materials, will dictate increased usage of the microform.

Consequently, management needs to challenge and reappraise all of its information-handling practices from cradle to grave. Each record series and each document collection should be analyzed with a view to determining which data should be recorded in machine-language code and where it would pay to use the microform. All steps and processes involved in document preparation, distribution, and use should be studied similarly.

Typical Problems

This article is concerned with identifying a dozen typical information problems or needs which might be solved, all or in part, by the use of the microform. It is not possible to ignore the computer altogether, however, since, in many instances, it is a full partner to the microform or it plays another important role in providing the answer to a particular problem or need.

It is not the intention of this article to imply that the microform should be considered a panacea for all of the dozen problems cited in the following paragraphs: (Nor is it likely that in any given situation, only one of the following problems exists. One objective, therefore, should be to find out, in any given situation, how many of these problems exist. Each existing problem becomes, in effect, another vote for a microform system. A detailed cost/benefits study and some testing always are needed to arrive at the final conclusion.)

Problem: File Integrity

- Errors in filing;
- Accidental loss or destruction of information;
- Alteration and obliteration of information; and
- Users failure to return documents.

Errors in filing occur in spite of the best efforts of file supervisors. If the file is a large one, it may be days, months, or years before a missing document turns up. Whenever a document is removed from a file and forwarded to a user, it risks being lost in transit, accidently destroyed, damaged, or not returned. These, of course, are serious problems when dealing with important documents such as those affecting individual rights and claims.

Often, the best way to insure absolute file integrity is by converting documents to a microform system. The user is provided access by furnishing a film-to-film copy, or an enlarged paper copy for his use.

Problem: Document Accessibility

- Travel problem; and
- Competition problem.

It is usually possible to keep small collections of documents that occupy a file cabinet or book case near the users. But, the larger document collections, by necessity, usually are located at some distance. This means that either the document or the user has to travel back and forth to the storage site.

Further, there are times when the same document

is needed at the same time by more than one user and each has to wait his turn to get it. These problems, of course, cause work delays. They also tend to reduce the usefulness of the information contained in the documents, since the users are inclined to try to do without them if they can.

Both problems could be solved through the use of a microform system. Once the documents are converted to a microform, inexpensive duplicate sets can be established at various locations in the users' work areas. A second choice, which solves the competition problem, only, is to make film-to-film copies and send them to the users when they ask for them.

Problem: Document Preservation and Protection

- Prevention of wear and defacement of valuable irreplaceable documents;
- Protection of indispensable operating records against a disaster; and
- Protection of classified documents.

The Library of Congress and the National Archives use microfilm extensively for preservation of important documents. The microfilm copies, rather than originals, are made available to scholars and researchers.

Microfilm is used by many agencies for protection of indispensable operating records against a fire or national disaster. The film is usually kept in a remote, protected depository which, in most instances, is equipped with machines and supplies for making film-to-film copies or paper enlargements.

The original copies of classified documents may be microfilmed so that either the original or copy of the document is always secure. However, control of the microfilm copies presents its own special problems.

Problem: Storage and Handling of Large- and Nonstandard-Size Documents

- Special equipment needs;
- Folding and unfolding of oversize documents; and
- Storage of documents with irregular sizes and shapes.

Oversize documents, such as tracings, drawings, and maps, can be recorded on microfilm, thus eliminating the problems of special-equipment requirements and the need for unfolding and folding the documents each time they are used. However, the original documents must conform to certain quality standards in order to produce a satisfactory microfilm substitute.

Documents having irregular sizes and shapes can be reduced to a uniform size through microfilm. Improved color microfilm is available if color is a significant factor.

About The Author:

Robert H. Cain is the Assistant Director of the Paperwork Standards and Automation Division of the National Archives and Records Service in the General Services Administration (GSA). He received recently the GSA's Meritorious Service Award for his initiative and leadership in performance of his additional duties as a staff specialist on information retrieval and as a consultant in this field to other Federal Government agencies.

He was working for the Navy Department before 1941 and, during World War II, served with the Army Air Force—flying 50 combat missions in the European Theater. He was with the Veterans Administration from 1945-61.

He conducted seminars and workshops for several years on information retrieval and has written numerous Federal Government publications and articles for magazines and professional journals.

His memberships include the American Society for Information Science, the Society for American Archivists, and the American Microfilm Association. He has served as seminar chairman for the American Management Association.

His education includes completion of courses required for qualification as a Chartered Life Underwriter. He also attended the University of Richmond, Virginia, the Department of Agriculture Graduate School, and The American University, Washington, D.C.

Problem: Document Servicing and Control

- Man-hour requirements for pulling folders and preparing document charge outs;
- Man-hour requirements for filing returned documents;
- Man-hour requirements for following up on unreturned documents; and
- Man-hour requirements for routine document maintenance.

If a microform system is used, inexpensive diazo copies of the documents can be made and given to the user instead of loaning the file copy. The user disposes of the duplicate copy when he is through with it. Thus, there is no document charge out and refile problem, and file maintenance is reduced to a minimum.

Because personnel costs are increasing constantly and it is difficult sometimes to obtain file clerks, it is to be expected that there will be increasing situations where it will pay to change to a microform system.

Problem: Document Acquisition

- Rising cost of hard copy publications; and
- Acquisition of rare and one-of-a-kind documents.

The rising costs of publications printed in paper copy are making it necessary for many libraries, offices, and others to curb their document-acquisition programs. In those instances where a document is available in either paper copy or microform, savings of 70-to-90 percent can be realized by purchasing it in microform.

There are many times also when desired documents are rare or out of print. If such documents are needed urgently, the simplest and, usually, cheapest way is to have microform replicas made. This may make it necessary for the acquisitioning office to bear the microfilming costs. It is a small price, however, to pay for valuable documents. Many governments and private organizations follow such a practice.

Problem: Document Printing, Distribution, and Stocking

- High costs for printing, collating, and packaging of paper documents;
- Transportation and handling costs;
- Stock control and replenishments costs; and
- Time-delay problem.

Many government agencies discovered some years ago that the most economical and efficient way to reproduce, distribute, and fill individual requests for unpublished reports is by means of the microform. Federal agencies within the Department of Defense, in particular also are saving untold thousands of dollars each year by using the microform for reproduction and distribution of engineering drawings of military equipment. The U. S. Patent Office is following a similar course for publication and distribution of patents. The Naval Supply Systems Command has decided to use a microform system for publishing its 9,000-page, 20-volume series of Navy Catalog Data.

As the use of microforms expands and microform readers become more commonplace, there will be an increasing demand to make printed documents available in microform as well as paper copy. In instances where government agencies are not preparing a microform copy, commercial publishers often fill the void.

Not only is it sometimes possible to reduce the initial printing costs, but significant savings are realized in handling and transporting of documents. Stocking usually can be eliminated altogether, since the microform at the original source or at any distribution point can be used to reproduce on demand low-cost film-to-film copies or enlarged paper copies. The original microform can be produced readily by photographing paper documents. However, with the advent of computer-assisted document preparation, editing, index preparation, formatting, and Computer-Output-Microfilm (COM) equipment, direct publication of documents in microform is now possible. The computer-output magnetic tape also can be used to automatically print paper copies. For many agencies, these new techniques offer the means for substantial reduction in the time lag between document drafting and receipt by the users.

Problem: Updating and Maintenance of Manuals and Catalogs

- Total costs for individual updating of manuals and catalogs kept at numerous locations;
- Errors and delays in individual updating of manuals and catalogs; and
- Keeping large, heavily-used manuals and catalogs intact and in good condition.

The updating of maintenance and procedural manuals, catalogs, and similar publications can be a time-consuming and thorny problem if there are many of them and they are maintained at numerous locations. Errors are made in entering the changes, while the insertion of some changes is delayed or never made at all. If the manuals and catalogs receive heavy use as they often do in a maintenance shop, the pages are likely to be torn and lost. When detailed information is needed at the job site, the mechanic may have to copy the information by hand or remove the page.

In most agencies, no one knows just what this is costing or the full effects of not having current, accurate data on hand at each user location. However, in those instances where a detailed study was made, such as at some of the airlines, the savings were sufficient to pay for the cost of the microform system in a short time. Additional benefits, appearing under other problem headings in this article, also are being realized.

One of the ways to solve these problems through microform is to maintain a single master copy in cut-sheet form at a central point. Changes are entered in this master copy as they occur. The entire master copy is periodically re-photographed, reproduced in microform copy, and distributed to the users; whereupon, they simply dispose of the entire old copy. The microform readers are often equipped with a paper copier so that mechanics can make throw-away copies to take back to their job sites, if desired. The microform might also be produced, in some situations, through the use of the computer and COM equipment, as previously described.

Problem: Equipment and Space for Document Storage

- Availability of adequate space to house documents;
- Space costs; and
- Equipment costs.

While space-and-equipment savings are often an important plus in a microform cost/benefits analysis, it is

seldom that microfilming can be justified for this purpose alone. Inactive records, for example, can sometimes be stored at a General Services Administration Federal Records Center for a period of perhaps as long as from 10 to 70 years for what it would have cost to microfilm them. The current annual cost for maintaining documents in a Federal Records Center is approximately 65.6¢ per cubic foot.

Problem: Retrieval Speed and Costs

- Random lookup of individual items of data;
- Examination of graphic information; and
- Scanning and retrieving information in textual documents and indexes.

In situations where there are a large volume of data which can be converted readily to a microform, retrieval speeds sometimes can be increased for a very small additional cost by use of this medium. This is particularly true of instances where retrieval involves random lookup of individual items of discrete data such as a social security number, date of birth, or street address. Special devices and techniques are often used to make retrieval easier and faster.

Manufacturers of roll microfilm equipment, for example, offer self-threading readers using film cartridges. Techniques such as automatic image counting, binary-coded film, code lines, and an odometer-like device can be employed to locate rapidly specific microfilm images. The Division of Disbursement, Treasury Department, for example, has, through the use of microfilm, reduced file searching time on check issues by 80 percent.

If there is a continuing need for examination of graphic information – such as large maps, engineering drawings and photographs – microform often will make the job faster as well as easier. Also, scanning or browsing of large collections of textual material and indexes is sometimes easier and faster if they are available in microform.

Over-all retrieval speeds and costs can often be improved because of the fact that when using a microform system it is possible to store needed documents and data at the user's work station, rather than having to keep them at a remote location.

Problem: Procedural Bottlenecks

- Collection and transportation of large volumes of data;
- Verification of data on documents passing through the system; and
- Logging documents.

Collection and transportation of large volumes of data such as questionnaires and reports can be a "knotty" problem if they are retained in their original paper form.

The U. S. Census Bureau, Department of Commerce, solves this problem by having the census questionnaires microfilmed at various locations in the field. The microfilm is then shipped to their headquarters office at Suitland, Maryland, where it is placed upon a microfilm optical mark reader known as FOSDIC ("Foto" Optical Sensing Device for Input to Computer). It converts the data to machine language code for processing by computers. The Census Bureau also uses the FOSDIC system for collecting and converting internal administrative data.

The Veterans Administration and other agencies receive large volumes of checks from the public. The checks are microfilmed while being processed through the system in order to verify any data that may later be questioned. For similar reasons, organizations using Optical Character Recognition equipment for computer input sometimes microfilm incoming documents.

The Division of Disbursement, Treasury Department, must maintain a record of each of the 1½ million checks it issues each day. In the past, this was done by preparation of a paper record. Using COM equipment now, the record is produced directly from magnetic tape, making it possible to place the issue record for 102,000 or more checks on a single roll of microfilm. Duplicate microfilm copies of each month's veterans'-benefit check issues are sent to over 50 Veterans Administration regional offices throughout the United States where the microfilm is used to answer approximately 8,000 inquiries a month, conduct post-audit operations, obtain an historical record of payments in specific cases, and locate addresses.

If it is necessary to log documents in and out, microfilming is usually a far simpler and cheaper method than keeping records by hand. Many libraries use this technique for charging out books.

Equipment manufacturers have developed lightweight portable cameras, including some that are battery operated, which add to the practicability of using a microform for all of these purposes.

Problem: Computer Data Storage and Accessibility

- Storage and retrieval of machine language backup data;
- Storage and retrieval of static or semi-static data; and
- Direct access to computer master file.

It doesn't take long for a computer to fill a 1,500-foot reel of magnetic tape with data. If it is kept busy all day, the computer may have produced dozens of tape reels to add to the tape library. It is little wonder, then, that some computer installations have thousands

of tape reels or millions of punched cards in their file and must often restrict the computer master files to summary data. While this backup data resulting from input processing end other machine runs is essential usually to system documentation, it is often too costly, due to its great volume, to retain it in machine language and search it by computer. The Social Security Administration was among the first to use the microform and the first to procure a COM device to solve this problem.

While the computer provides the fastest and most accurate means for compiling, updating, and organizing static and semistatic data, the size-and-cost limitations of mass memories and the time requirements often make it impractical to use the computer to retrieve data from these files. Often, the best solution to the problem is to convert data recorded on magnetic tape to a microform by means of COM equipment. The Census Bureau has developed another version of its FOSDIC optical mark reader which can read and process data on a microfilm copy of punched cards. The U. S. Weather Bureau at Asheville, North Carolina, is using this system for processing its file of some 40 million cards.

Such computer data bases as inventories, transportation schedules, rates, and special tables can be converted periodically to microfilm and then searched by means of standard microfilm readers. Where static information such as airplane flight schedules ties in with dynamic data like reservations data maintained "on-line" with the computer, special remote terminals have been designed to permit the users to interrogate both data bases at the same time.

Most large Automatic Data Processing (ADP) systems, by necessity, must use batch-processing techniques and access the master file on a cyclical basis; perhaps, once or twice a day, once a week, or possibly less frequently. During the interim, the data is locked up in the tape reels and inquiries must wait until the next processing cycle comes around to be answered. The Air Force Finance and Accounting Center at Denver, Colorado, which processes and maintains pay and allotment data for Air Force military personnel, has solved the problem of round-the-clock inquiries by converting, periodically, the data to microform by means of COM equipment. Inquiries and requests for changes can now be handled quickly and efficiently by nonskilled personnel equipped with microfilm readers.

Information Retrieval Guidance

The National Archives and Records Services of the General Services Administration provides information and guidance in all phases of information retrieval, and also operates microfilming service centers throughout the country. It is, of course, aware that microforms are not without their faults and disadvantages. In addition to problems of personnel, equipment, and supply costs with microform information systems, a major obstacle may be obtaining user acceptance. For a microform to serve as a satisfactory substitute for paper copy, it must be as legible and easy to use as its paper counterpart. Success depends upon the quality of the original documents; the film; the camera; the camera operator's work; the quality of film processing; the suitability of the microform type; and the adequacy of viewing equipment. A weakness in any of these areas may cause the microform system to fail.

The condition of the documents not only largely governs the quality of the finished microform but is a major cost factor in the filming operation. Typical problems are poor light reflecting contrast between the reading matter and the paper; extremely fine lines or printing; lack of uniformity in color, sizes, and thickness of documents; intermingling of one-sided and two-sided documents; need for removal of staples, pins, and other fasteners; and need for sequence checking and screening to remove extraneous material. Such problems as these account for the fact that, as mentioned earlier, it is often possible to maintain records in a Federal Record Center for many years for what it would cost to microfilm them. Within the next 10 years, it can be expected that most of the existing large-folder file systems in the Federal Government will be converted to microform. Steps should be taken as soon as possible, therefore, to clean up and revise such systems so that the essential papers will be susceptible to low-cost, high-quality microfilming.

Most of such problems could be avoided, of course, through proper planning and care in establishment and maintenance of a document file. When establishing either a microform or paper-document file, serious consideration should be given also to capturing and maintaining key identifying data in machine language. Using source data automation techniques, this can be done for a small additional cost at the same time the labels are typed. The machine-language record should prove highly useful as a means for automatic preparation of finding aids, inventory lists, and new labels by a computer and the purging of the file.

The wisest course of action in establishing any new, long-term file is to plan and maintain it as though it were to be later microfilmed. The chances are that it will be!

* * * * *

Guide For A Microform Systems Designer

By Commander Robert C. Baker, USN*
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A microform system consists of a set of equipments that allow information to be stored and used on microform. It is made up of three equipment subsystems:

- A photographic subsystem (recorder, duplicator);
- A retrieval subsystem; and
- A viewer, printer subsystem.

The following could serve as a guide to the areas that a microform system designer needs to explore in order to gather facts that will specify the kinds of microform equipment that will allow the microform system to be responsive to the needs of the persons who operate the equipment. As a result of analyzing the way persons operate a microform system, a system designer can determine the specific equipment needed in each of the three equipment subsystems of a microform system.

Importance of Index

An additional "subsystem" is required, however, to make a microform system work: The index. Without an index that is responsive to the needs of the user, documents on microfilm or hard copies are as good as lost.

Information from microform documents is used generally to be responsive to three broad classes of tasks:

- To locate the answer to a specific question;
- To locate all of the information in the system that relates to a specific topic; and
- To keep aware of new information in a specific area or group of areas.

After determining the nature of the specific task for his system, the systems designer must develop, or select, an indexing system that will match that task. This will be a demanding task that should begin with a thorough review of existing indexing keys such as policy, invoice, drawing number, or subject headings.

The indexing system should be designed first since it will help to determine how the documents will be placed in the file (microformed) and the nature of retrieval equipment.

Recorder Vs. User

Those who operate a microform system generally belong to two basic groups—recorder or user. The "recorder" is the organization, agency, or office that places the information on microform. The organization, agency, or office that stores and/or uses the information that has been placed on microform is the "user." The person who designs a microform system, therefore, should consider, as a minimum, the factors in the following paragraphs.

Recorder Analysis

A designer should analyze the organization responsible for recording information on microfilm, taking into account that:

- Paper forms, books, and photographs become torn, discolored, wrinkled, soiled and fragile with age and that, as these conditions become severe, the photographic process becomes more difficult and reaches the point where special procedures and/or equipment may be required. (Frequent or intensive use of original documents before micro-recording may impose similar difficulties.)
- The physical size of the document to be reduced to microform influences the frame size and, therefore, the reduction ratio of the photographic subsystems. Occasionally, the original documents will exhibit a wide range of sizes. Large maps and drawings are difficult to accommodate in a system using letter-size documents. Photographic systems to accommodate extreme ranges are more expensive than similar systems designed to accommodate one-or-two document sizes. Accordingly, it may be necessary to design a system to accommodate the majority of the documents and to handle the over-sized documents by other processing.
- To replace documents by microform, the original document must be reproduced on film. The document and its information are reduced in size and generally transformed to a black-and-white image. An analysis of the document must be made to determine if significant information is "color-coded." (For example, red-debit figures are not distinguishable from black-credit figures after being photographed with black-and-white film.) A system designer must determine, therefore, how important

*This article by Comdr. Baker is based upon remarks of Thomas C. Bagg of the National Bureau of Standards before the 1969 meeting of the National Microfilm Association.

color is for preserving the information on a document. Additionally, the systems designer must consider the size of the smallest character and the resolution required for recording the closest lines. This determines the maximum reduction ratio which can be used throughout the system. Resolution (ability to separate closely-spaced objects) is only one of several image parameters required for legibility; line density; opacity of character images; contrast (difference of opacity between character images and background); and sharpness (rapid change in contrast at edge of character images) also are necessary qualities. Only resolution and gross densities, however, can be measured conveniently. There are no good legibility tests. The systems designer must rely, therefore, upon real-life tests to determine the legibility of a microform product.

- Some documents are complete in one page and others are in book form with many pages. Documents can represent all of the gradations in between. The format of the document will determine the type of mechanism needed to display the document for photograph and the manner in which the information is oriented on the microform.
- Almost invariably, the justification for a particular equipment configuration will rest with the volume of documents to be handled. If the collection to be recorded is small, it may be more economical to have the filming done by a local commercial microfilmer. If it is a very large collection or one which grows rapidly, in-house filming may be quicker and more economical. The rate at which changes are made to the original documents and/or the rate at which the original documents are replaced along with the original number of documents determine the volume of work to be handled by the microform system.
- The manner in which changes are incorporated into the microformed records is important. Changes that have to be made immediately may dictate a system that can reproduce single or small-lot items economically; otherwise, changes may be allowed to accumulate until they can be processed economically. Some changes will be "added to" the original document—with both the original and the change being retained in microform. Others will supercede the original document completely and require that the original document be removed from the microform file and the change replace it. It seems clear that all combinations and permutations of timeliness and replacement requirements may exist and may have to be accommodated.
- The distribution of the microformed documents (both the number of individual addressees and the number of copies that are sent to each addressee) will determine the volume of work for the system that makes copies of the microformed document. It is necessary, therefore, to examine the distribution of the microformed documents in detail. The frequency with which the documents are now distributed is a good point of departure for considering how frequently the microform document and changes thereto should be distributed. However, consideration should be given to the economy and usefulness of changing the frequency of the distributions of the microformed documents and incorporating the "to date" changes. Centrally-produced microform documents allow changes to be made once and a complete up-to-date document distributed. This procedure saves the field activities the effort and time involved with making the change and in addition insures that all of the documents throughout the system are the same.

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User Analysis

In addition to the above considerations, the designer of a microform system should consider the following factors that can be determined by analyzing the organization that uses the information placed on the microform. Microform, by the fact it can not be read by the unaided eye, requires that the user have available to him equipment that will allow him to search out and read the information contained on the microform. The equipment in this part of the total microform system must be designed and/or selected with as much care and thought as the equipment in the photographic subsystem; otherwise, the entire system is useless.

The manner in which the microformed documents are used will determine the characteristics of the equipment used.

- The number of persons who use each microformed document and the number of times each person uses

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Micromation For Data Dissemination

By Calhoun Smith
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Computers perform a tremendous amount of work in solving complex information management problems and updating voluminous files. An undesirable feature, however, has been overwhelming mountains of paper-printed output—much of which no one reads. In some situations, this time-and-space consuming output can be replaced by semi real-time, direct-inquiry systems which display on a Cathode Ray Tube (CRT) device, or a typewriter-like printer, the desired record or piece of information from the file. This is expensive, however, in programming effort and systems equipment. Another method of avoiding the "paper-mill" hallmark of computer operations is becoming widely used and constitutes a major improvement in the effectiveness of computer utilization. It is called "COM."

"COM"—the microfilm industry's abbreviation for Computer-Output Microfilm—is the "third-generation" method of mass-data dissemination. It provides for the transfer, at tape-drive or computer-channel speeds rather than impact-printer speeds of alphanumeric data from magnetic tape or computer memory to microfilm. Coincidentally, data is converted from digital to legible English form. For the ultimate user, it combines the rapid response of the CRT display-device with the permanence of a printed record. For the computer operations manager, it releases the computer from "typewriter" drudgery and can have the effect of up to 20 (1,100-line-per-minute) printers working simultaneously off line. Transfer rates of up to 500,000 characters per second can be obtained. With the proper family of off-line equipment, one operator can produce developed microfilm images of approximately 100,000 standard size computer print pages (14" x 11"—64/132-character/lines) in an eight-hour shift. For the office manager, it provides improved accessibility of data with roughly a 500-to-1 reduction in storage space. This may be translated also to a saving in numbers of personnel.

Three Types

Computer-Output Microfilm currently is produced by three methods: One method is to photograph an alphanumeric display of data on the face of a CRT. The second method is, in effect, to cut off the bulb of the CRT and pass the film by the "throat" of the tube where it is "written on" by the electron beam emitted by the "gun" at the base of the throat, much as one would burn an inscription on wood with a hot poker. This is called an Electron Beam Recorder or "EBR." The third method is a type of microfilm printer only recently announced. A number of manufacturers produce the first type; one manufacturer produces the second type; and one manufacturer is planning to supply the third type.

The first two methods require input of formatted digital data on magnetic tape via a tape drive connected to a converter. The converter employs electronic circuitry to convert the digital data to analog signals which are directed to the electron gun of the CRT. In the first method and most widely used equipment, the electron "gun" in the CRT emits a stream of electrons which is passed through the desired aperture of a character matrix and causes the image of the character to be displayed on the face of the tube. The microfilm camera faces this CRT and as the characters are formed on the CRT—each in its proper space and line of the page or "frame"—the image is recorded on the microfilm. When the desired data for that page has been recorded, an instruction or action record on the magnetic tape causes the camera to space the film up and a new page is started. This method uses ordinary "wet" process silver film. Output of five pages per second can be obtained.

In the EBR equipment, a dry silver film is used in the camera. Latent images are etched on this film by the electron beam which is moved by the analog signals generated by the electronic circuitry. The line spacing and film movement is similar to the first method. The film is then passed through an in-line heat treatment which brings out (develops) the latent images on the film and a readable finished product is thus produced in one pass. Again, output of approximately five pages per second is possible. The first method produces exposed negative film which then must be run through a developer in a separate sequential operation.

In both methods, a forms slide may be used to project the image of a "preprinted" paper form onto the film so that the heading information need not be repetitiously recorded on the magnetic-tape input.

New Method

The new third type of private-industry microfilm printer is designed to operate as a standard output peripheral with a Central Processing Unit (CPU). It connects directly to a CPU multiplexor or selector sub-channel and is buffered to accept up to 500,000 characters per second.

Throughput, however, is equivalent to writing on a 30,000-character-per-second tape drive and produces about 10,000 132-character lines per minute. This unit looks the same to the CPU as a paper printer. The significant technical advance embodied in this new microfilm printer is the system of light-emitting diodes and fiber optics (glass-like strands which can transmit light on a curved path). This method is reported to eliminate many of the adjustments required in other microfilm printers to maintain proper character resolution. The characters are formed by using an electronic translation matrix, a bank of light-emitting diodes, and a bundle of fiber optics for each character space in a line of print. The assembly is factory-aligned and sealed, supposedly never requiring adjustment. The film is passed by the line of fiber optic bundles and a whole line of print is recorded on the microfilm at one instant, then the film is spaced and the next line of print is emitted from the ends of the fiber-optic bundles onto the film. It is quite similar to the operation of a standard-line printer and it is said not to require any program changes to utilize this unit in lieu of a standard printer. Just give it an address when defining the system and use this address in job control cards. This new method is restricted to on-line operation.

In the most efficient third-generation systems not using COM, the report output is formatted on a print tape which, in a multi-programming mode, is then fed to the impact printer under control of a special output handler running in a small partition allocated by the operating system or supervisor. In a COM system, likewise, the output is formatted on a magnetic tape for later off-line conversion to microfilm. This completely releases the computer from comparatively low-speed printer output. As in formatting an impact-printer report tape, the programmer must follow certain conventions specific to the equipment in use.

Report-Tape Records

Generally, the conventions are as follows: Most COM functions are controlled by records on the report tape. Tape records are either "print" records or "action" records. Print records contain line spacing and horizontal and vertical tabbing control characters and data. Print records are separated by a record mark. Action records cause film movement and must be followed by an Inter-Record-Gap (IRG). The stop-start time of the tape drive incidental to the IRG is utilized for advancing the film the proper distance for recording the next frame. No data is recorded or "printed" from an action record. Action codes are available for halts to provide a break for operator manipulation between stacked reports on a particular run; end of file or reel; and "No-Operations" (No-Op) to enable block padding to the next IRG when required. Blocks of records should conform to frame size or content, as a rule, to optimize throughput. The details to be considered by the programmer vary with the different manufacturers' equipments and are covered by complete programmer reference manuals. The preceding was provided to indicate that no great programming burden is involved in implementing COM. For a going system, conversion programs or equipment features are available to translate existing print tape macros to COM macros or to treat existing print tapes as specially formatted COM input tapes.

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The author served nearly 30 years in the Marine Corps of which the latter eight years was as a Data Processing Officer (1952-1960). After retiring in 1961, he performed duty as a systems analyst in connection with implementation of a Navy system, became operations manager of a data processing facility for a Navy contractor, and, finally, returned to work for the Marine Corps in 1967.

Speed Plus Legibility

One of the most fascinating facets of the COM system is the speed with which data can be presented in legible form for the ultimate user. As mentioned earlier, a COM system can produce 100,000 pages of data in an eight-hour shift. One might say "Yes, but this provides only one original copy of the data." True, but this "master" can be used to produce any desired number of film copies—in an overlapped mode on the proper equipment. The first complete copies can be delivered or mailed to the user within an hour after the final reel of film is completed on the magnetic tape to microfilm operation. This copying phase replaces the standard decollating and bursting/binding phase of a standard multi-copy printer run. In the many applications requiring more than six copies, the elimination of additional runs on the printer becomes a major savings factor which increases in direct proportion to multiples of six copies. Also to be considered is the fact that many times the sixth copy of a run is hardly legible but the sixtieth copy of a microfilm run is the same as the first (given correct processing quality.)

Cost Saving

The comparative cost of producing microfilm copies versus paper-printed copies must be measured for each application. This is because of the various types of equipment and numbers of copies which bear on the cost considerations. The following analysis will provide, however, an idea of the type of savings to be expected. Consider an application resulting in a monthly report of 5,000 pages (50 132-character lines/page plus header lines) which is

distributed to 15 users. Three five-part print runs are used to produce the best paper printed output. The two methods considered are equal during the preparation, file update, and the output on a print tape. The computer system consists of a computer, a printer, and five tape drives running under a standard Operating System.

The micromation system consists of a COM printer with a tape drive, a film developer, and a duplicator. An example of a comparative cost for first shift operations shows a total cost of over $1,000 for paper printing compared to about $100 for microfilming.

A further savings to be considered depends on how many copies of a report must be mailed. The weight ratio of printed report copy to microfilm copy is about 50-to-1. The larger the file volume and the more frequently printed out, the greater the savings to be obtained by converting to microfilm. Large, fairly static, descriptive files such as stock lists, parts catalogues, and applications data are excellent candidates for conversion to microfilm. A large dynamic file, frequently updated, and involving reference by many users at widely separated locations (geographically), such as a personnel locator file, is currently the most advantageous example of a microfilmed reference file in use by the Marine Corps.

Quite a number of manufacturers are now producing microfilm converters. These equipments vary considerably in capability as to speed of data transfer, versatility as to camera, and compatibility with various manufacturers' computer equipment such as tape drives and CPU's. Some converters can be connected directly to the CPU channel, thereby receiving data at computer speed and eliminating the "print tape" step. Such an arrangement is highly critical at this time, however, and must be carefully planned and technically implemented to obviate delays in computer operation due to film loading and unloading and checking for legibility of output.

The latest announced microfilm printer, as mentioned earlier, is engineered only for direct connection to the CPU channel and receives program data direct from memory via the channel. In deciding whether to have an on-line system, consideration must be given to whether or not a magnetic tape record of the output is required, the percentage of processing which will result in microfilmed output, and that, should the converter go down, those programs using it could not be run in their normal manner and sequence. The system planner should consider also the availability of commercial facilities for development, reproduction, and distribution of microfilm and copies. Such an arrangement has been found advantageous at this time by the Marine Corps. In some cases, it may be preferable to have steps subsequent to the recording of data or film performed by an administrative services facility rather than by the data-processing installation. In other cases, it may be desirable to send the magnetic tape to an outside activity for recording of data on microfilm as well as the subsequent processing.

The off-line, unified microfilm production systems have the widest application. New developments in equipment, however, maintain a dynamic aspect in the field of C.O.M. The advent of a new camera, for example, has brought a new versatility of form to microfilmed data, including automatic production of microfiche on 105 mm film.

The capability for automatic production of microfiche has provided incentive toward development of microfiche viewers which are much simpler in design and operation, not needing a motorized transport system such as is required for roll film. Using greater reduction ratios for recording data on microfilm and given viewing equipment (readers) with compatible "blowback", or remagnification ratios, more and more data can be accommodated in less and less space and yet accessed or viewed more and more rapidly.

Micromation appears to be the greatest boon to mass dissemination of data since the third-generation computer came along to process it faster.

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Overview of Microfilms

(Continued from Page 6)

exposure to students in universities and the military service schools. This is particularly true for "microfiche". (Examples of military service schools are the U. S. Naval Academy at Annapolis, Maryland, and the U. S. Naval Postgraduate School at Monterey, California.)

Another incentive for future acceptance of microfiche is the trend toward micro-publishing. For example, the 170,000-member Institute of Electrical and Electronics Engineers now offers its major periodicals to subscribers in "microfiche" format in place of printed copies. The printing of thousands of paper technical journals may disappear from the future scene. Imagine this microform issue of NAVY MANAGEMENT REVIEW on "microfiche"!

* * * * *

Computer Micro-Graphics To Speed "Third-Generation" Management

By Thomas G. Doran
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In all too many instances, the characteristics of management information systems today remain similar to those of several years ago. The much-heralded advent of third-generation computers did not automatically result in third generation management information systems. Management, while well aware of the potential of the computer, is only too aware that voluminous paper reports are still the computer's most frequent output.

It is increasingly evident that if the team of management and the management systems analysts are to provide improved systems and concepts for dynamic management and decision making, it must break with the tradition of the past decade. Designers of some sophisticated systems promise the manager direct access to his data. The end result, too often, however, is another unwieldy and complex alphanumeric message; this time, on the face of a Cathode-Ray Tube (CRT) terminal. Such displays are not effective tools for communication to middle- and top-management. People often understand information best when it is displayed in graphic form.

Computer graphics provide a management systems analyst with an almost unlimited array of graphic formats for displaying information and focusing the attention of the manager. An awareness of the potential of computer graphics can be a step to better communication of management data.

Non-Impact Printer Project

Late in 1966, systems designers of the Army Material Command (AMC) initiated efforts aimed at improving the flow of computer information to the operational levels of the Command and to the Army in the field. Concurrent with that effort, research commenced on various computer techniques which could support improved information displays for all levels of management. Subsequently, in early 1967, the Department of the Army approved a three-phase project known as the AMC Non-Impact Printer Project (NIPP).

The objective of phases one and two of the Project was to determine, by prototype tests, the feasibility of operating high-speed Computer-Output Microfilm (COM) and film-processing centers within an Automatic Data Processing (ADP) environment. In early 1968, the Department of the Army agreed that results of the tests warranted expansion of COM to other Army facilities where warranted by ADP print volumes.

One of the major aspects which weighed heavily in this decision, was the enthusiastic acceptance of microfilmed data at both the operational level of AMC and the Army in the field. Eight COM systems are in operation now within AMC, with others planned for the future. The COM systems have stemmed effectively the avalanche of paper into the operational level of the Command.

Collectively, during the 12 months preceding September 1969, a staggering total, exceeding 100-million pages of computer paper, was eliminated from the functional areas of AMC. Advantages were not confined to the customers of ADP services: By diverting computer printing to their "off-line" COM systems, hard-pressed ADP managers were able to free over 20,000 hours of computer time.

Graphic-Format Management Reports

The third phase of NIPP was devoted to the development of ADP techniques required to produce management reports in graphic format. Through the use of computer records, a special graphic software package and CRT Printer-Plotter (a new dimension) was added to displays of management information. This technique, known as Micro-Graphic Reporting (MGR), owes its success to a small group of business and scientific computer programmers and management systems analysts of the U. S. Army Missile Command (MICOM), a major subordinate command of AMC. Working from a concept paper, the scientific programmers of MICOM supplied the hands-on programming experience required to drive the CRT Printer-Plotter while their business programmers supplied the data base and display requirements needed to support the many facets of a management information system. The final product derived from the effort is a highly versatile, graphic software package which will accept statistics and quantitative factors from such in-

formation systems for logistics, personnel, or finance and plot them into a variety of time-phased graphic displays. (See Cover Illustration.)

While CRT Printer-Plotters have been in use for over a decade, their use, in general, has been confined to scientific and engineering recording applications such as flight trajectories, oil logging, and atomic recordings. Why designers of business-information systems have done little to exploit plotters, on even a moderate scale, it can probably be attributed to a lack of awareness of the subject. The myth that plotters were difficult to program was no doubt a constraining factor also. In the MICOM exercise, however, the business-type programmers have handled the programming problem with little, if any, difficulty.

The Micro-Graphic Report concept is designed to provide mid- and top-management the information needed and in a format conducive to quick understanding and, most important, in a time-frame conducive to effective management decisions. The MGR concept, using 16 mm microfilm output from a CRT Printer/Plotter, encompasses the display of three segments of business system data. First is the "operational" line-item data required for daily clerical needs. (For example, the status of procurement contracts and work orders would be displayed in tabular form.) The second segment, appropriate to "mid-management," displays in graphic format the highlights of the completed cycle such as pin-pointing workloads and problem areas. (Relating to procurement, the displays, for example, might reflect the collective amounts of obligations relating to contracts awarded during the month in such categories as small business, cost-plus-fixed-fee, and competitive.) The third and final segment of the MGR report is designed to provide "top management" with displays which reflect performance and trends against objectives offer a wide time frame. (For example, the Director of Procurement may establish objectives to award a certain percent of the overall fiscal year contract funds to small business and the balance through competitive procurement.)

The MGR software plots the annual objective to scaled displays with a display being produced for each procurement category. Against each display, actual performance for each month is plotted in the form of a continuous and variable trend line. Twelve months of actual performance is accommodated normally in each display.

By producing all three levels of information from a common data base, coincident with the same computer cycle, several advantages are accrued: First, all levels of management have access to the bits and pieces which make up the complete picture. The MGR's are produced automatically; thereby, greatly reducing the possibility of management acting on filtered informa-

tion. By using the full resources of a visual language, assimilation of information is greatly enhanced; while, conversely, the possibility of misinterpretation is greatly reduced. To quote an old adage: "A picture is worth a thousand words."

Finally, by having access to information—undeteriorated by the effect of extensive time delays—management has a chance to act and make timely adjustments which will improve the likelihood of their meeting objectives. The use of graphics as a management tool is not new. What is new is that management can now expect and get from the management information system a new dimension to analyze his problems and support his decisions.

In April 1969, the Director of the Management Information System for AMC, directed the MGR concept be put into operation. Almost coincident with that decision, he assigned the Logistic Systems Support Agency at the Letterkenny Army Depot in Chambersburg, Pennsylvania, the mission to act as the consolidating point for an AMC Command Information System. One of the initial tasks was to implement Micrographics Reporting.

The initial MGR products go directly to the heart of AMC's vast operations, depicting performance related to the many facets of a logistic system. Graphically portrayed in time-phased displays, for example, are performance in stock availability (ability to fill a requisition from stock) and percentages and number of backorders versus requisitions at each Army National Inventory Control Point (NICP). Performance indicators from Army Depots, also are displayed. (Examples are the number of receipts, number of shipments, and tons of storage.) Each group of MGR displays, reflecting performance at the NICP's and Depots, is preceded by a MGR display which depicts the consolidated AMC performance and provides management with the overall picture as well as the pieces which make up the whole picture. Distribution of the MGR products is made to Command Group levels of AMC Headquarters; Major Subordinate Commands; and Depots.

The MGR displays, currently viewed in microfilm readers, also are adaptable to large screen displays for group conference discussions. To assure a high degree of uniform interpretation, each group of MGR products is accompanied by an information brochure which describes each display and defines the data elements used in its make up.

Branching out from the areas of supply, inventory, and transportation, MGR's are now produced in the areas of procurement, quality-assurance, maintenance, and research and development. Other areas are under development and will be added as data flow networks are established. As the statistical data base for each functional area is structured, it becomes a segment of a Micromaster

File stored in random-access storage. In a later phase, exception reporting and selective correlation techniques will be applied. By use of these techniques all important facets, such as inventory or procurement problems, and major items or weapon systems will be displayed graphically side-by-side for review by top management. Use of the interleaved-graphic concept with a large screen and random-access display system will allow managers to sit together and view the MGRs while interacting with each other on obvious relationships of men, money, and material problems. In many cases, presentation of the correlated picture will provide management with enough information for immediate adjustments and decisions. Perhaps even more important, it may provide the basis for decisions on what not to attempt. Having enough information to avoid costly mistakes is a very high must when it comes to the management of high blocks of our national resources. The same exception reporting techniques, of course, would apply to systems and programs where "exceptionally good" performance is noted as well. In this manner, top managers who have neither the time nor inclination to look at every static display produced by the MGR system can appreciate the successes of the operation while applying corrective action to any problem areas. Responsibility for overall review of the MGR for each functional area lies in the respective Directorate or mid-management level of a Command.

By taking these basic steps to establish a sound statistical data base and deal with the real-world problems of making its supporting-data-flow network operational, AMC is preparing itself for more dynamic concepts of management support. The Micro-Graphic Reporting Technique and its static-display concept probably will continue as a requirement for many years to come. To place all statistical data associated with a Command Information System in a real-time computer available to many-remote stations would prove extremely costly. An intermediate step is to develop computer techniques which will support "scheduled" interactive exercises between operations research analysts or management executives and various modules of the statistical data base.

The first real link between the operations research analyst and the management executive could be an "on-line" graphic display. At scheduled intervals, the operations research analyst could call for certain files to be placed "on-line" to a computer which may be many miles from the display device. For example, should a management executive desire to determine the optimum workload and cost requirements for a series of new maintenance/overhaul programs, an operations research analyst would load into the computer the known production rates, cost factors, and resources parameters. By using appropriate computer routines, he can manipulate the data until he arrives at a series of alternative plans. Graphic displays, representing the results, could project charts which reflect various workload units and related costs of each maintenance/overhaul program. While the Operations Research Analyst may not solve all the problems, he can show management the alternatives and allow sound executive judgment to turn the analysis into effective management decisions.

The future of computer graphics holds many additional surprises, some of which are not too far away. Already, several successful experiments have been completed using color for a new dimension of understanding. Only months away is programmable color produced on high-resolution CRT Printer/Plotters for filmed graphics, geographical displays, and motion pictures. There will be soon "on-line" color CRT display terminals. At first brush, programmable color may sound like frosting on the cake, but results of early film tests have opened up a "motherlode" of exciting applications in the areas of management, engineering, and publications. Probably the best exercise for appreciation of color graphics is to compare black-and-white and color drawings of a circuit layout. Such a comparison leaves little doubt as to what color does toward improved understanding of a presentation.

Within the management environment, the use of Micro-Graphic Reporting will do much in the Decade of the Seventies to make the computer a closer ally in the decision-making processes. The speed-up and simplification of reports by graphic techniques will support long-range planning and, hopefully, reduce much of the tension currently associated with "third-generation" management. It will provide management with an opportunity to be better informed, more confident and in control of its mission.

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Microform Systems Designer

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microformed documents will determine the number and location of the microform viewer units. The timeliness with which microformed documents must be retrieved will be the determining factor in developing requirements for the retrieval subsystem. It is important to consider not only the fastest time response required but also the slowest response allowable and the number of times of the total usage each of these times is to be accommodated. Only extenuating demands would require a system to be designed to meet a timeliness requirement that would be imposed only infrequently.

- Microformed documents may be used for several reasons, each of which would impose different requirements. The user may want to see or compare an item of information on a document or a document itself; he may want to collect or assemble all available information on a specific subject or documents concerning a specific subject; or he may wish to modify or change the document or its information. Each of these needs places different demands upon the system for a full-size copy of the document that the worker can create himself and use apart from the microform system. Additionally, the final requirement (the ability for the user to modify or change the microformed document) generally is beyond the capability of current equipment–except for simple "line-overs" or coded, punched holes.
- The user must be able to understand the information on the microformed document as if he were looking at the original document. The requirement for legibility defined earlier is imposed upon the equipment of the viewer/printer subsystem every bit as much as upon the photographic subsystem. The user must be able to read the smallest character, resolve the closest line pair, translate graphic information from the screen of the reader or the paper copy he receives from the printer just as if he were looking at the original document.

Final Test

As a final task before submitting his system specification, a system designer should test the specifications and the system they represent against these three additional criteria:

- Is this system compatible with other document-handling activities in the same organization?

  Many organizations have need for several information systems using microforms as the storage media. Since cameras, processors, duplicators, readers, and printers may be required for each system, it would be desirable if the formats were the same. Where possible, an effort to minimize the number of formats should be made. Each application, however, should be carefully studied because the economics in time and money may well prove that totally different formats and equipment would have an overall advantage. Unfortunately there are only a few standards at this time for detailed microform formats. Where these are applicable, they should be used.
- Will the microform system result in savings of time or money?

  For other than archival purposes, any microform system must cause an economical saving in either time of personnel or money, if it is to be considered practical.
- Can the system meet all of the needs of the people who will be using the system?

A "no" answer to any of these questions does not invalidate a systems design but it should cause the designer to review his work and justify the exception.

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